Small Business Innovation Research/Small Business Tech Transfer

Clean Catalysts for Water Recovery Systems in Long-Duration Missions, Phase II

Completed Technology Project (2015 - 2019)

Project Introduction

A catalytic post-processor is the last unit operation that reclaimed water typically sees before being consumed by the crew, therefore the entire sub-system must be safe, reliable and well-understood. The key innovation required to provide a sub-system for longer-term missions is to develop catalyst technologies that maintain a high degree of activity and physical stability over multi-year operational lives. The high catalytic activity of noble metals combined with the surface area and adsorptivity of activated carbon are the ideal combination of parameters for achieving the highest level of performance at the lowest penalty for a post-processing sub-system. The problem has been the physical breakdown of traditional activated carbon catalyst supports. To address this problem, the Phase I and previous intermittent research efforts have shown that noble metal catalysts supported on Porous Solid Carbon, exhibit superior physical properties to alumina, ceramic and granular activated carbon-supported catalysts currently used by NASA and throughout the chemical process industries. The Porous Solid Carbon-based catalysts are proposed due to their remarkable hardness and physical stability combined with their high surface area and surface activity. Phase I continued the successful demonstration and scale-up of the technology, demonstrating that the reactors can be manufactured with high surface area and porosity and good internal consistency, as well as demonstrating that the catalytic activity is extremely high under very mild conditions. The Porous Solid carbon reactor scale-up will be completed in Phase II to International Space Station-sized reactors that will be fabricated, tested and characterized using advanced analytical methods that will yield a fully quailifiable protocol for manufacturing the reactors for Phase III flight implementation.

Anticipated Benefits

Long-range missions will benefit from upgraded catalytic post-processing reactors for both water recycling and air revitalization systems; multiple NASA programs can benefit from this technology. The opportunity for immediate implementation in the ISS Water Recovery System exists, and application of longer-life, more catalytically robust reactor technology to manned Mars missions, where re-supply options are even more constrained, is essential.New PSC-based catalyst materials will provide benefits in sustainability, energy efficiency, selectivity and process economics that will help US manufacturing industries optimize the value of our petrochemical resources in global markets, maintain and create all-important manufacturing jobs in the US, fuel increased exports of American goods to worldwide markets, and provide a significant, sustainable source of geopolitical capital to the United States. Scaled to production quantities, Porous Solid Carbon has a high degree of potential to be a true breakthrough in the field of materials science. These physically stable and catalytically robust materials will have wide-ranging application throughout the chemical process industries, potentially impacting areas within

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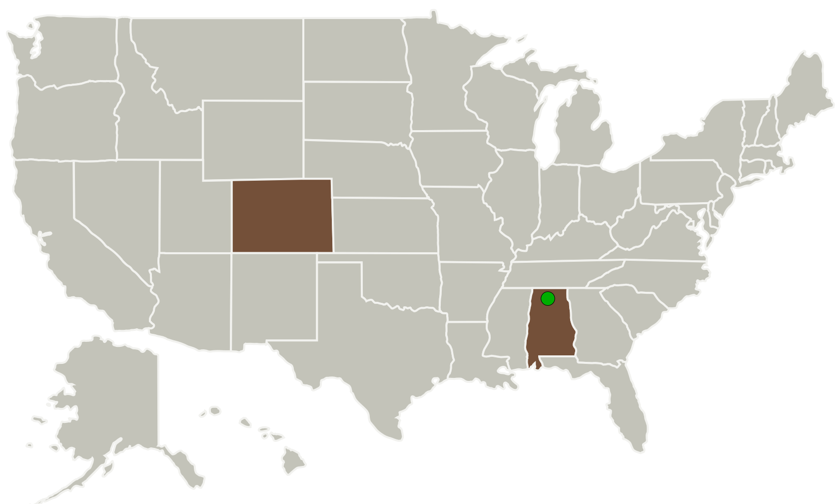
as much as 75% of a global catalyst market projected at >US$24B by 2018. Examples include hydrotreating to reduce sulfur in fuels, olefinic monomer purification via selective hydrogenation, and potentially game-saving applications in several high-profile gas-to-liquids projects. The multiplicative impact is even greater- over $3T per annum in products are manufactured using catalytic processes. Sustainability impact is also high-- application of PSC to pollution control will provide a massive level of social benefit by reducing discharge of organic pollutants on people and place, helping to reverse the decades-long environmental problems plaguing Asia and other parts of the world.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Environmental and Life Support Technology, Inc.	Lead Organization	Industry	Parker, Colorado
Marshall Space Flight Center(MSFC)	Supporting Organization	NASA Center	Huntsville, Alabama

Primary U.S. Work Locations	
Alabama	Colorado

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Environmental and Life Support Technology, Inc.

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

Carlos Torrez

Project Managers:

Gwenevere L Jasper
Donald L Carter

Principal Investigator:

Clifford Jolly

Project Transitions

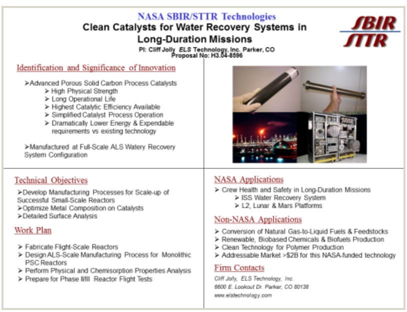
June 2015: Project Start

September 2019: Closed out

Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/137519)*

Images

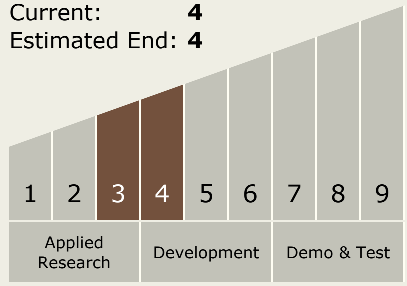


Briefing Chart

Clean Catalysts for Water Recovery Systems in Long-Duration Missions Briefing Chart *(https://techport.nasa.gov/image/137080)*

Technology Maturity (TRL)

Start: **3**
Current: **4**
Estimated End: **4**



Target Destinations

The Moon, Mars, Outside the Solar System, The Sun, Earth, Others Inside the Solar System